NOTES ON THE POLLINATION OF *NUYTSIA FLORIBUNDA* (LABILL.) R. BR. (LORANTHACEAE) AND SOME LITERATURE REVIEWED

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ABSTRACT

A preliminary list of insects and birds, observed feeding from flowers of the Western Australian Christmas Tree, *Nuytsia floribunda* (Labill.) R. Br., during two summers between 1977 and 1979, is provided. Observations were undertaken between Jurien Bay (30°15'S, 115°03'E) and Perth (32°00'S, 115°50'E). There appears to be considerable disagreement in the published literature concerning aspects of the flower morphology, anther dehiscence and seed production of *Nuytsia*. Considering the large number of viable seeds produced by a given naturally occurring plant of *N. floribunda*, it is suggested that an efficient pollination and reproductive system operates. It is postulated that native insects, unlike previously thought, *do* constitute a large proportion of the pollination vectors of *Nuytsia*. The most efficient pollinators are considered to be beetles and wasps.

INTRODUCTION

Nuytsia floribunda (Labill.) R. Br., the well-known hemiparasitic Christmas Tree of Western Australia, mostly grows to 7m tall and occurs sporadically from the Murchison River in the north, to the south coast as far east as Israelite Bay and as far inland as Kellerberrin. During November and December, trees abound in masses of orange flowers which are visited by various nectar-feeding insects and birds. Since little has been recorded on the pollination vectors of *Nuytsia*, it was felt that the observations and discussion presented below would be a basis for further detailed studies on animal/plant relationships.

Observations on insects (mostly jewel beetles, Coleoptera: Buprestidae) and birds visiting flowers of *N. floribunda* in various areas of Western Australia during November — December 1977-79, are recorded below. (The majority of observations have been undertaken by Messrs M. Peterson and D.G. Knowles).

A. INSECTS

1. Jurien Bay area. (a) Bees and wasps (Hymenoptera) — *Apis mellifera* L. (Apidae); *Zaspilothynnus variabilis* (Kirby) (Tiphiidae); *Scolia (Discolia) soror* Sm. (Scoliidae); two species of unidentified wasps from the families Sphecidae and Pompilidae. (b) Flies (Diptera) — numerous unidentified flies from the families Calliphoridae, Tachinidae and Asilidae. (c). Beetles (Coleoptera) —*Stigmodera (Themognatha) obscuripennis* Mannerh., *S. (T.) reichei* Laporte and Gory, *S. yarrelli* Laporte and Gory, *S. (Castiarina) filiformis* Blackburn, *S. (C.) placida* Thomson, *S. (C.) robusta* Saunders, *S. (C.) rufipennis* (Kirby), *S. (C.) sanguinolenta* Laporte and Gory, *Neocuris discoflava* Fairm., *Neocuris* sp. (Buprestidae); two unidentified species of Cleridae. Incidental insects (not regarded as pollinators) from the families Cicadidae (Hemiptera) and Chrysopigidae (Neuroptera).

2. Gingin area. (a) Bees, wasps and flies — (As for Jurien Bay area). (b) Beetles — *Stigmodera (Themognatha) obscuripennis, S. (T.) yarrelli, S. (T.) reichei, S. (Castiarina) amabilis* Laporte and Gory, *Neocuris discoflava* (Buprestidae); two species of Cleridae (same species as at Jurien Bay).

3. Perth Area. (a) Bees and wasps — *Apis mellifera* L; two unidentified wasps from the families Sphecidae and Tiphiidae. (b) Beetles — *Stigmodera (Castiarina) occidentalis* Barker, *S. (C.) elongata* Saunders (Buprestidae). (c) Flies — five species from families Tachinidae and Tabanidae.

B. BIRDS

Three species of birds have been observed by Mr M. Peterson during the past several years, commonly visiting flowers for nectar in the Perth area. These are the Red Wattlebird *(Anthochaera carunculata)*, Brown Honeyeater *(Lichmera* [*Gliciphila*] *indistincta)* and the Singing Honeyeater *(Meliphaga virescens)*.

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DISCUSSION

(a) Floral morphology.

Narayana (1958) completed a detailed embyological study of *N. floribunda* from material sent to him from the Perth district (Carrington and Crawley). In this paper, he describes in detail, the floral morphology of *Nuytsia*, in somewhat different terms than employed by Blakely (1922b, p.200) and in the more recent redescription of the species by Barlow (1966, p. 447).

The sessile flowers are brilliant orange yellow in colour, 10-12mm long and are grouped in three's in a racemose inflorescence (Narayana, 1958, p. 306). Barlow (1966, p. 447) states that the "inflorescences (are) solitary in the upper axils and terminal". Hence there is a discrepancy between the two authors' interpretations. However, Narayana (1958, p. 306) states that the central flower in each group of three is bisexual while the two lateral ones are staminate and "wither away to allow the ovary of the central flower to develop into a three-winged fruit". He also notes (p. 306) that "There is a prominent swelling at the base of the style which may function as a nectary". Barlow (1966) makes no mention of this nectary, but Blakely (1922a, p. 23) states that flowers of most Australian mistletoe species produce large quantities of nectar (including *Nuytsia*).

Blakely (1922a, p. 23) stated "Nearly all the flowers of the Australian species of *Loranthus (=Amyema)* and *Phrygilanthus (=Meullerina)* contain much nectar, and therefore are sought after by many honey-eating birds. On examination, many of the flowers in the field will be found with small punctures at the base and sometimes in the swollen part near the attachment of the filaments". He adds (1922a, p. 23) that the floral tube of some species may be filled for more than half its length with nectar.

The large quantities of strong scented nectar produced by *Nuytsia* flowers is largely responsible for attracting birds and large numbers of insects.

(b) Early literature on pollination

Sargent (1918) first recorded observations on the pollination of *N. floribunda*. He briefly stated that the flowers are pollinated by birds because "the structure of the flower incline me strongly to the opinion that birds are the official pollinators ..." (Sargent, 1918, p. 216). Sargent (1928) cites only one bird (the Brown Honeyeater, *Gliciphila indistincta*) as a pollinator of *N. floribunda*, since "The parts of the *Nuytsia* blossom are rather rigid, which points to a vigorous pollinator. The flowers are borne in immense trusses; and when a bird alights on a truss to sip the proffered nectar, it is highly probable that wholesale pollination takes place" (Sargent, 1918, p. 216). However, in his 1918 paper, Sargent also makes a brief mention of honey-bees *(Apis mellifera* L.*)* visiting flowers, "but though they often brush against the anthers, I have never seen one touch the stigma" (Sargent, 1918, p. 216).

It seems surprising in the light of the observations presented here, that Sargent did not observe any native insects on flowering *Nuytsia* bushes. It is likely that his observations were made in the Perth area where the domestic honey-bee has been common since early habitation by European man. As pointed out in this journal by Douglas (1977), the honey-bee *Apis mellifera*, because of its high fecundity and aggressive nature, is able to compete successfully with, and subsequently dominate the feeding niche usually shared by the various native bees, flies and beetles previously common in these areas. Such native insects are thus vulnerable to competition by introduced species such as the honey-bee and the practice of large-scale land-clearing for agriculture, destroys the breeding grounds of many native insect species. This is especially the case with beetles from the families Buprestidae and Cleridae. Most Australian buprestid species rely on native plants for survival both in the larval and adult stages (e.g. Carter, 1933; Hawkeswood, 1978; Hawkeswood, 1980b; and Peterson Hawkeswood, 1980) and are usually unable to utilize naturalized plants. Since both larvae and adults of almost all Cleridae prey upon other insects, especially insects associated with bark and wood of trees, e.g. Scolytinae (Britton, 1970) and adults are often found on flowers, they are also dependant on plants for survival. The effect of bees and land clearing practices are probably reflected in the fact that more insect species were found on flowers of plants growing in

areas such as Jurien Bay (22) than around Perth (10).

Blakely (1922a, p.18) was of the opinion that all the Australian species of *Loranthus* (now *Amyema* [Barlow, 1966]) "that have come under my observation are self-pollinated, as the anthers are fully developed and the pollen released from them simultaneously with the opening or bursting of the petals. The close proximity of the stigma to the anthers, and the powdery nature of the pollen facilitate the work of self-pollination.."

Blakely proceeds to state "the nectar-feeding birds assist in the fertilization of the flowers, ..., as it is quite possible that some of the flowers ... may accidentally be fertilized by visiting birds, as their bill is bound to be saturated with pollen as they forage amongst the flowers in quest of food. It must be admitted that the percentage of flowers pollinated by birds in some districts is remarkably small, seeing that there are no examples of hybridism, though the opportunity for such is very often favourable". He adds (1922a, p. 19) "Many species are without doubt pollinated by insects and many of the buds show punctures made by small grubs". However, he does not give any examples of insect-pollinated mistletoes or their insect vectors.

On the whole it would appear that mistletoe flowers are adapted for bird-pollination, but little has been recorded for Australian species; the only literature being that of Sargent (1918, 1928), Blakely (1922a) and the recent paper by Paton and Ford (1977) who recorded 20 species of birds feeding from flowers of *Amyema miquelii* and 6 of these species also feeding from *Lysiana exocarpi*.

(c) Notes on the pollen

Narayana (1958, p. 308) states that the pollen grains of *N. floribunda* are "tricolpate and are released while the flower bud is still unopened. Sterility of the pollen and the degeneration of even entire pollen sacs are common". He also adds (1958, p. 306) that "The anthers are usually sterile due to insect attack". In contrast, Sargent (1918, p. 216) states that "The simple erect subulate style is crowned by a minute apicular stigma, which appears to be ripe at anthesis simultaneously with the anthers. The only trace of dichogamy I have noticed is that sometimes a few of the anthers do not dehisce on the day the flower opens" (indicating that dehiscence occurs, in this case *after* the flower opens).

It would seem reasonable that anther dehiscence occurs at the time of bud opening or after the flower opens so that pollination by insects or birds can be facilitated. In addition, it is likely that the purpose of producing large quantities of fragrant nectar is to attract large numbers of vectors so that many flowers are assured pollination.

Since Narayana (1958) studied only a small amount of material sent to him in India from Australia and was not able to observe *Nuytsia* flowering in the field, it is likely that he made an error or was unable to furnish a more complete understanding of the time of anther dehiscence. Also, he does not state when the stigma is receptive nor provides any information on pollen germination. Although it is likely that there are many flowers per plant that possess sterile pollen (as mentioned by Narayana, 1958) but at the same time, many flowers may possess viable pollen capable of fertilizing other flowers on the same plant or nearby plants. Barlow and Weins (1977) note that although mistletoe flowers are generally adapted for insect or bird pollination some "appear to be self-compatible and may be frequently self-fertilized (Blakely, 1922a; Barlow, 1966; Andrewartha, 1972)." Further observations on animal/flower relationships of Australian mistletoes are clearly needed.

(d) Seed production

Herbert (1919) noted that "The immense development of flowers is all the more remarkable since so few fertile seeds develop. Many trees do not develop a single seed; others may develop a number — a very small number in comparison with the tremendous number of flowers — but very few of these are fertile". This is in contrast to Blakely (1922b) who recorded a colleague's observation of numerous *Nuytsia* seedlings which had germinated from fallen seed under certain trees, but had died off because of exposure to strong

sunlight. It is generally known amongst some botanists in Western Australia, that naturally occurring *Nuytsia* plants produce large numbers of viable seed, although to date (July 1980), there has been no published information on seed production. It is felt that Herbert's statements noted above, are somewhat erroneous, and that an efficient pollination and reproductive system must be operating in *Nuytsia*.

(e) Final discussion on Insect and bird vectors

The vector data presented in this paper strongly indicate that insects are the main pollinating agents, and of these (excluding the introduced honey-bee), beetles and wasps appear to be the most efficient pollinating agents. The following reasons are presented: (a) individuals often spend considerable time feeding from flowers, (b) individuals have been observed to carry considerable dustings of pollen on the head, thorax and undersurface of their bodies (which in many species are softly pubescent), (c) adults push their head far into the flowers when feeding on nectar, and (d) frequent flower visitation by any particular individual may occur on one plant and between adjacent plants.

It is well known that honey-bees, *Apis mellifera*, are efficient pollinators of numerous plants. Their introduction by European man into the Western Australian bush has made them important pollinators of *Nuytsia* at the expense of native hymenopters. They probably facilitate the majority of pollination in areas such as the Perth district where they have a high population density.

Large native flies (e.g. Tachinidae) probably also facilitate pollination since their hairy bodies are adapted for the contact and transport of pollen. However, considering the little time they spend (5 seconds in many cases) on any one flower (or flower cluster), it is doubtful whether pollen would be placed on the stigma unless large quantities of pollen were carried on the body at the time of visitation. The number of flowers visited per unit time is likely to be less than that for beetles and wasps which require greater amounts of nectar for energy.

The importance of beetles in the pollination of many Australian plants has not been fully realized, although it is generally known (e.g. Britton, 1970) that adult beetles from numerous families (e.g. Scarabaeidae, Cleridae and Elateridae) visit flowers. Observations by the author during the past several years (e.g. Hawkeswood, 1978; 1980a; 1980c), following the natural history notes of Carter (1933) have suggested that jewel beetles (Buprestidae) and flower-chafers (Scarabaeidae) can be important pollinators of small-flowered Myrtaceae which offer large supplies of nectar during the summer months when adults are on the wing.

Although nectar-feeding birds are known pollinators of many Australian plants, they probably do not play a major role in *Nuytsia* pollination since insect visitation is much more frequent.

SUMMARY

The literature regarding the taxonomy, ecology and reproduction of *Nuytsia floribunda* has been reviewed and differences in opinion between various authors pointed out. Field observations indicate that native insects (beetles and wasps) (excluding the honey-bee) are the main pollination vectors. Further observations on animal/plant relationships are needed.

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REFERENCES

ANDREWARTHA, D.M. 1972. Studies in Australian mistletoes. Breeding system and pollination ecology. (Unpublished Honours Thesis, Flinders University). (Not seen; cited from Barlow and Weins, 1977).

BARLOW, B.A. 1966. A revision of the Australian and New Zealand Loranthaceae. *Aust. J. Bot.*, 14: 421-499.

BARLOW, B.A. and D. WEINS. 1977. Host-parasite resemblance in Australian mistletoes: the case for cryptic mimicry. *Evolution*, 31: 69-84.

BLAKELY, W.F. 1922a. The Loranthaceae of Australia. Part I. *Proc. Linn Soc. N.S.W.*,47: 1-25.

BLAKELY, W.F. 1922b. The Loranthaceae of Australia. Part II. *Proc. Linn. Soc. N.S.W.*, 47: 199-222.

BRITTON, E.B. 1970. Coleoptera. chapter 30. In: *The Insects of Australia.*, C.S.I.R.O., Melb. Uni. Press, Carlton, Victoria.

CARTER, H.J. 1933. *Gulliver in the Bush.* Angus & Robertson, Sydney.

DOUGLAS, A.M. 1977. Some inimical effects of the domestic bee on the native fauna and flora. *West. Aust. Nat.*, 14: 1-2.

HAWKESWOOD, T.J. 1978. Observations on some Buprestidae (Coleoptera) from the Blue Mountains, N.S.W. *Aust. Zool.*, 19: 257-275.

HAWKESWOOD, T.J. 1980a. An adult food plant of *Ethon breve* (Coleoptera: Buprestidae). *West. Aust. Nat.*, 14: 198.

HAWKESWOOD, T.J. 1980b. Jewels among the beetles. *Wildlife Australia*, 17: 9-10.

HAWKESWOOD, T.J. 1980c. Jewel beetles as pollinators of *Melaleuca pauperiflora* F. Muell. between Eucla (W.A.) and Koonalda (S.A.) *West. Aust. Nat.*, 14: 238-239.

PETERSON, M. and T.J. HAWKESWOOD. 1980. Notes on the biology and distribution of two species of *Diadoxus* (Coleoptera: Buprestidae) in Western Australia. *West. Aust. Nat.*, 14: 228-233.

HERBERT, D.A. 1919. The Western Australian Christmas tree. *J. & Proc. Roy. Soc. of W.A.*, 5: 72-78.

NARAYANA, R. 1958. Morphological and embryological studies in the family Loranthaceae. — III. *Nuytsia floribunda* (Labill.) *Phytomorphology*, 8: 306-323.

PATON, D.C. and H.A. FORD. 1977. Pollination by birds of native plants in South Australia. Emu, 77: 73-85.

SARGENT, O.H. 1918. Fragments of the flower biology of Westralian plants. *Ann. Bot.*, 32: 215-231.

SARGENT, O.H. 1928. Reactions between birds and plants. *Emu*, 27: 185-192.

THE DESERT COPRINUS FUNGUS *(PODAXIS PISTILLARIS)* IN WESTERN AUSTRALIA

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Few naturalists will be unfamiliar with the Shaggy Ink Cap, *Coprinus comatus*. Its tall, narrow white caps are a familiar sight on disturbed land such as building sites or road verges. Some readers may be in the habit of cooking it, for it is good to eat when young, before the gills darken and the spores develop.